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Department of Mechanics
Lehigh University
Bethlehem, Pennsylvania

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SUBJECT: Fourth Semi-Annual Progress Report

REPORT PERIOD: March 1, 1965, through August 31, 1965

GRANT: N.A.S.A. NSG-466 - Study of Atmospheric Turbulence and its Effect on a Vehicle During Launch

A. Personnel

The principal investigator was Dr. Ferdinand P. Beer, Professor and Head, Department of Mechanics. His chief collaborator during the period covered by this report was Mr. William C. Lennox, Instructor in Mechanics.

During the summer months, the following graduate students were added to the project staff:

- Mr. Walter Henkel, June 1 - August 20
- Mr. Peter D. Hilton, June 1 - July 31
- Mr. Robert J. Ravera, June 1 - June 15
- Mr. Robert R. Regl, June 1 - June 30

Messrs Henkel and Regl had been awarded N.A.S.A. Fellowships, beginning September 1, 1965. By participating to the project during the summer, they were given the opportunity of an early start on their research, as well as an orientation toward problems of interest to the Structural Dynamics Branch of the Langley Research Center. Messrs Hilton and Ravera were given problems of limited scope but of direct interest to the project. They were both able to complete the work assigned to them during their period of employment.

B. Research Performed

The research performed was concerned with various aspects of the general problem of the prediction of the response of a mechanical system to a random input field, with application to the determination of the probability of survival of a launch vehicle from statistical information on the wind-velocity field.

The following phases of the problem were considered:

1. General characteristics of the response of a space and time-dependent linear system to a multidimensional nonhomogeneous nonstationary random field.

2. Modal analysis in the case of a time-invariant linear system.

3. Calculation of the bending moment response of a typical launch vehicle using generalized power spectral techniques.

4. Effect of spacewise variations in a random load field on the response of a linear system.

5. A method for simulating nonstationary processes by filtering white noise.

6. Optimal control of a nonlinear system moving through a random load field and subject to failure at a given stress level.

Phase 4 was summarized in a report to the sponsor and in a paper submitted for publication to the AIAA Journal. Phase 3 will soon be presented in a report to the sponsor. Phases 1, 2, 5, and 6 are being written down in the form of separate papers which will be made available to the sponsor in the near future and submitted for publication to various journals.

Two papers reported as having been submitted for publication in the Third Semi-Annual Progress Report have now been accepted for publication. They are

"Determination of the Survival Probability of a Launch Vehicle Rising Through a Random Wind Field" by F.P. Beer and W.C. Lennox, accepted for publication by the Journal of Spacecraft and Rockets.

"First-Occurrence Time of High-Level Crossings in a Continuous Random Process", by J.R. Rice and F.P. Beer, accepted for publication by the Journal of the Acoustical Society of America.

7. Funding and Duration

A balance of \$7,965.20 existed at the end of the second year of operation under this grant. This balance was added to the funds made available by N.A.S.A. under the extension of the grant for the period from September 1, 1965, to August 31, 1966.

Ferdinand P. Beer

Ferdinand P. Beer
Principal Investigator
Head, Department of Mechanics

WPB:mb